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Hydrogeological and Geophysical characteristics of Selected Watersheds in Parbhani district

Synopsis submitted

For the conformation of Ph.D. Topic

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Geology

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By

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Abstract:

The present study seeks to investigate the Morphometric and Lithological features of the Wazur, Lasina and Thar watershed of parbhani District to reveal the Hydrogeology of the study area. Morphometric study comprises measurements of linear, areal, and relief attributes with an aim to understand hydrologic characteristics of the watershed. Morphometric study have been assessed using GIS and can be linked to the previously discussed geomorphology in the M. Phil thesis. Geomorphological expression alone cannot reveal the Groundwater potential. However, characterizing the nature of the feature at depth with integrated geophysical methods provides essential information for assessing that potential. This research intends to assess the subsurface lithology and geology of watersheds via Geophysical electrical resistivity surveys and a survey of dug wells to pinpoint regions with possible groundwater resources. The geophysical Investigation is carried out with Vertical Electrical Sounding (VES) technique using the **Schlumberger** configuration within the investigated study area. The morphometric characteristics of the study area aim to analyze the pattern of the sub-basin concerning with Groundwater potential. The morphometric study and geophysical study is aimed to search the behavior of the watershed and to find out heterogeneous or homogeneous behavior of the subsurface strata in the point of groundwater potential study.

INTRODUCTION

Geomorphological study using GIS combined with Ggeophysical electrical resistivity surveys with vertical electrical sounding provides valuable insights regarding spatial and variation of the aquifer's lithology in terms of depth.

Geomorphometry is the science "which treats the geometry of the landscape", and quantitative procedure of the land surface (Chorley et al., 1957). The morphometric characteristics of any watershed scale may have important information regarding its formation development and spatiotemporal variations because all hydrologic and geomorphic processes occur within the watershed (Pareta et al., 2021). The use of GIS for morphometric analysis of natural drains and their drainage network is proved to be better and time saving.

The morphological parameters gives information about its formation and development (Phupate et al 2021). The present research is carried out with the combination of geological, hydrological and geomorphological attributes, which is termed as the hydrogeomorphological characteristics of the watershed/basin (Babar and Kaplay, 1998,Babar, 2003,Babar 2005,Babar et al. 2010 and Babar 2011).

In present research computer based Geographical Information System (GIS) tool is used for study. GIS is utilized for generation of thematic maps like slope map, drainage network and geomorphological maps (Dikshit-2020).

Geomorphological expression alone cannot reveal the Groundwater potential keeping this in mind the second objective of the research is Geophysical electrical resistivity survey, which is helpful to achieve the goal of research. The geophysical Investigation is carried out with Vertical Electrical Sounding(VES) technique using the **Schlumberger** configuration within the investigated study area.

Groundwater occurrence being subsurface phenomenon and it can be influenced or controlled by geographical, geological, geomorphological and morphometric parameters of watershed.

Such morphometric data attempt to correlate with geophysical measurements of electrical resistivity to provide a better understanding of the subsurface lithology and hydrogeology of the study area.

This research examines the groundwater system in basaltic hard rock, its behavior, recharge and extraction by incorporating dug well inventory with geophysical resistivity, which will be helpful for the sustainable development of water resources.

Previously, lots of study has been carried out on Geomorphology Hydrogeology by different researcher, but very little work done on Geophysical Electrical Resistivity combine with Geomorphology in Wazur, Lasina and Thar watershed of Godavari river basin. Geologically, Wazur, Lasina and Thar watershed of Godavari river basin lies in Deccan volcanic province. Deccan trap is entirely covered with basaltic rocks.

About the Study Area

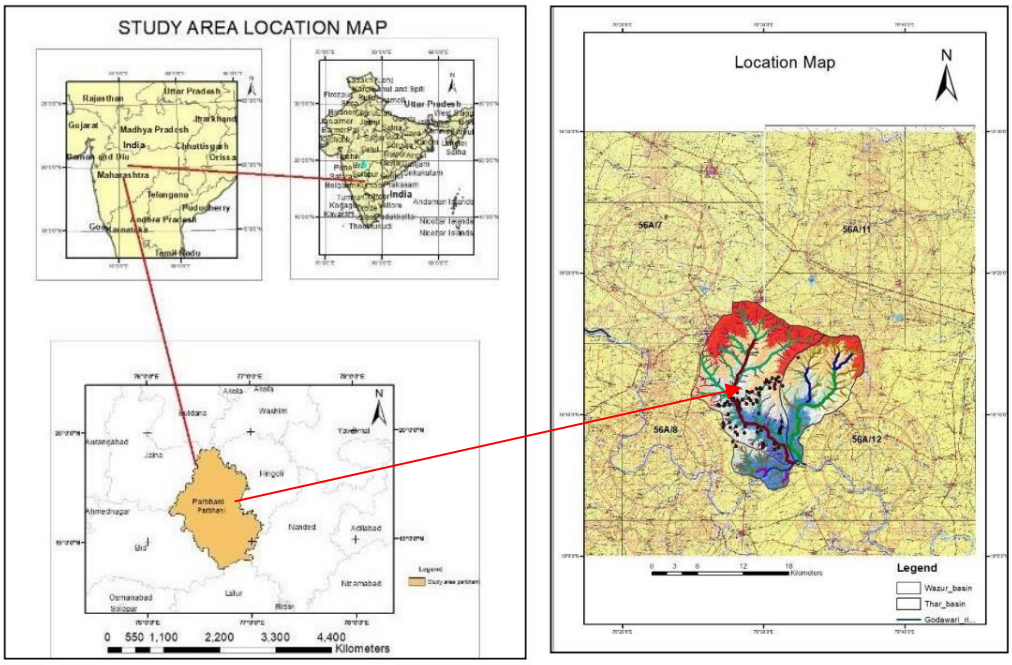
The research study area is a part of Godavari river drainage in Parbhani District, Maharashtra. The area is located in Pathri and Manwat Taluka of Parbhani District.

The Pathri and Manwat taluka both consists of the cluster of seven villages in each are studied in the present research.

The Pathri taluka extend from Latitudes N19°15'00" to N19°22'00" and Longitudes 76°12'30" E to 76°20'00" E.

Manwat is the second taluka with seven villages extending from Latitude N19°07'20" to N19°12'10" and Longitude 76°26'40" E to 76° 32'40"E.

The villages Sarola(BK), Kekarjavla, WazurKH, WazurBK, Thar, Chate pinpalgao Waghalla are part of the survey of India toposheet numbers 56A/11, 56A/7, 56A/12, 56A/8, 56A/3, and 56A/4. The study area covers 335.58 square kilometers.



Location Map of study area

Objectives

- To find out the **Hydrogeological characteristics** of the study area using well inventory
- To determine the subsurface lithology and geology of selected watersheds in Parbhani district through the application of **Geophysical electrical resistivity** survey technique.
- To Determining the **Impact of Geomorphological features** on the **Groundwater potential**.
- To **Suggest potential site** for **Recharge** and effective **Groundwater management.**

PREVIOUS WORK

1) Geological and hydrogeological setup

The primary aspect for initiating research work is conceptual understanding of geological setup of the area.
This can be achieved by studying the geological study of Maharashtra, followed by the geology of Parbhani district. Parbhani district is a part of Deccan volcanic province (DVP). The Deccan Traps are the largest geological formations in the Deccan Peninsula of India (Adyalkar et al;1971)
The lava of DVP is outpoured through fissure type of volcanic eruption for the duration of late Cretaceous to early Eocene and comprises of nearly horizontal

flows (Godbole et al. 1996). In the lava flow sheet joints, secondary porosity play important role in groundwater occurrence (Lawrence 1985; Kulkarni and Deolankar 1995; Babar 2002).

Hydrogeology

Groundwater occurrence and movement in the area is influenced by its porosity through joint and pore spaces in the rock formations. Groundwater potentially depends upon porosity and permeability (both primary and secondary) of rock formations (Waghmare, 2013)
Deccan Traps were influenced by lava flows, as well as the area's climatic and geomorphic conditions. The primary porosity in Deccan basalt is in the form of vesicles, flow contacts and lava tubes (Singhal 1997). These vesicles and pipe are not interconnected therefore, though basalts have primary porosity it does not influence the groundwater potential.
The presence of groundwater in the Deccan Traps exists in semi confined condition in the fissures, fractures, joints, cooling cracks, lava flow junctions and in the intertrappean beds.

2) Remote sensing, GIS and Geomorphology

The integration of data is very important for comprehensive understanding of study area various tools and techniques were used for geomorphological studies. The traditional methods for creating such a database are expensive and time-consuming. Topographic data can be stored, collected, managed, processed, analyzed and presented using remote sensing (Dapke, et al2024).

GIS is an effective tool for analyzing spatial and non-spatial data on drainage, geology, landforms to understand their interrelationships (Reddy et al 2004).
Remote sensing data offers impartial insights into geology, geomorphology, and structural features (Rokade et al. 2012).

Geomorphology is the examination of landforms and their formation processes, where each landform is shaped by unique processes or similar landforms are shaped by varying agents (Gerrard 2012).

The identification and classification of basic geomorphological unit was carried out by various authors in India (Haridas et al. 1994, Babar 2005). The geographical features distinguished from the satellite images are useful for understanding hydrogeological and geological conditions of study area.

Dhakate et al. (2008) worked on Geomorphological and geophysical approach for locating favorable groundwater zones in granitic terrain, in Andhra Pradesh

Dikshit (2020) identified Groundwater Recharge Potential Sites in Man River

basin parts of Sangli, Satara and Solapur districts of Maharashtra in his work Geomorphological surfaces are correlated with Lineament density

The work on geomorphology of Parbhani district and nearby area was undertaken by Babar et al (2018), Babar et al. (2010) and Muley et al (2010).

3) Geophysical studies

Cost-effective methods are essential for identifying potential groundwater zones. Geophysical method is considered as the most suitable for investigating geological structures along with groundwater exploration.
The objective of VES is to record the changes in resistivity with depth and to correlate it with the available geological information to infer the depths and resistivity of the layers present
Electrical resistivity Techniques used in measuring electrical resistance of various earth materials, the four probe electrodes are used to measure apparent resistivity which can be used for interpretation of thickness of lithological units (Babar etal 2018)
The technique was suggested by many authors, who worked very well in geology and also in groundwater exploration (Vasantrao et al,, 2017). Many national and international authors use the proposed method in their region for understanding hydrogeological and lithological setup of area. Kumar Ashok and Srivastava (1991) tried to correlate Geomorphological unit, their geohydrological characteristics and vertical electrical sounding response near Munger, Bihar.

4) Morphometric analysis

Morphometric analysis requires measurement of the linear features, gradient and channel network contributing ground slope of the drainage basin. Many works have been reported a morphometric analysis using remote sensing and GIS techniques

The morphometric study addresses the areal, linear and relif aspects of the basins, which can be further correlated to understand the geomorphological and hydrogeological condition of the area.

The initial study of the morphology of the drainage basin began with the basic research analysis. It studies evaluation of streams. Morphometric analysis of a basin provides an indication about permeability, storage capacity of the rocks and gives an indication of the yield of the basin (Singh et al 2011)

METHODOLOGY

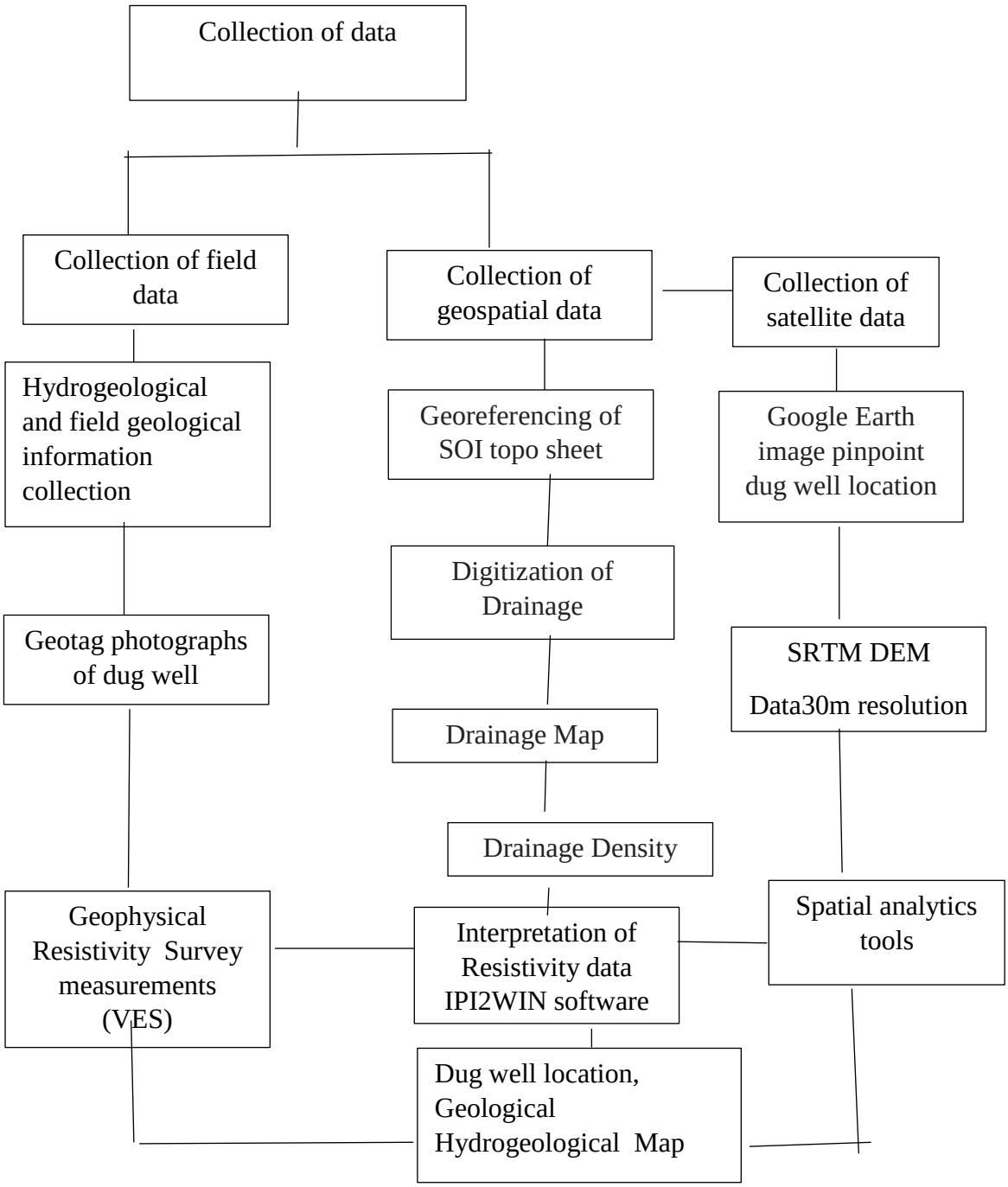
The following methodology will be adopted for the study of Hydrogeological and Geophysical characteristics of Selected Wazur, Lasina and Thar Watersheds.

Collection of data and tools used

1) Administrative map of Maharashtra and Survey of India toposheets will be used for pin point the location area
2) Utilize Google Earth image of the research area to indicate the positions of dug wells.
3) The base map of study area will be created in Arc Map application of the ArcGIS software. The Parbhani district boundary, will be clipped from Maharashtra to prepare base map
4) Geophysical Electrical Resistivity Survey technique will be used for identifying subsurface lithology, geology of the site, depth of various rocks with reference to their resistance. The electrical resistivity method gives fairly reliable results in Hydrogeological investigation.
5) Single Staking Resistivity Meter (SSR- MP-ATS) will be used to generate the data. The Resistivity equipment SSR- MP-ATS is manufactured by Integrated Geo-Instruments and ServicesPvt.Ltd,Hyderabad.
6) IPI2win software will be used for interpretation of Resistivity data.
7) Various maps like hydrogeological, morphological will be prepared.

Fieldwork and data collection

1) Data about the dug well, including its static water level, depth, and pumping hours, will be gathered in the field.
2) The georeferenced photograph of dug well shall capture for preparation of dug well location map and also for studying lithology of study area.
3) Agricultural crops and micro-irrigation information will be collected to study utilization of dug well and bore well water
4) Resistivity measurements will be carried out in the study area through Vertical Electrical Sounding (VES) survey.
5) The resistivity measurements obtained have been interpreted by curve matching technique and by using IPI2WIN geoscientific software.


Collection of data
Collection of field data
Collection of geospatial data
Collection of satellite data
Hydrogeological and field geological information collection
Georeferencing of SOI topo sheet
Google Earth image pinpoint dug well location
Digitization of Drainage
Geotag photographs of dug well
SRTM DEM
Data30m resolution
Drainage Map
Drainage Density
Geophysical Resistivity Survey measurements (VES)
Interpretation of Resistivity data IPI2WIN software
Spatial analytics tools
Dug well location, Geological Hydrogeological Map

Flow chart depicting broad methodology

Importance of study

In the present study it is intended to focus on geomorphology, morphometric analysis, and hydrogeological perspectives. The interdisciplinary research will be undertaken so as to focus on the geophysical, lithological, and hydro-geomorphological setup of the study area. This study will bring out the geomorphological changes of the study area. The results of geomorphological analysis may yield unique outcomes, regarding

bifurcation ratios, basin layout, sinuosity metrics, valley evolution, drainage configuration which will assist in correlating the geomorphological characters elsewhere in the Deccan plateau of India.

This study is important in groundwater point of view for the farmers in the study region. By combining modern remote sensing GIS tools with Geophysical electrical resistivity survey and dug well inventory, we aim to establish a connection between the lithology, geomorphology and hydrogeology of the research site.

The present research investigation will be valuable for farmers and other stack holders for understanding groundwater conditions in sounding area and best site for groundwater potential and groundwater recharge. The present data would be a useful document for future researchers.

Proposed work plan

First Year

Performing research include integrated approach and for better understanding first and important step is to critically examine previous work in the form of literature review.

The various sources of literatures as research papers conference proceeding, central ground water board repots, Groundwater Surveys and Development Agency repots (GSDA) will be revived for understanding geological, hydrogeological geomorphological setup of Maharashtra (Brief Hydrogeological Report On Groundwater Recharge Plan For Cluster No- 513Gv-71 02, Taluka - Pathri, District- Parbhani, Maharashtra.)

Second Year

Once the location is decided, a preliminary visit plan will be undertaken, which includes visiting Pathari and its surrounding villages in Parbhani district to study hydrogeological and morphological structures and to meet with local higher authorities.

Certain information will be gathered from farmers, such as their cropping pattern, water resources, and overall water usage. The information collected during the field study will help determine the next steps in the workflow process.

Third Year

The study area will be divided into smaller sections for conducting inventories of dug wells, which include water levels in the summer, water levels in the winter, and pumping hours. Along with dug well inventory, the Resistivity measurements will be carried out in the study area

The georeferenced photograph of dug well will be taken to compare the lithology with the resistivity of rock layers. In addition, it will be tried to collect field data like rock outcrops, land use information, river morphology. Data collected from various locations in the field will be compiled using different software programs.

Information gathered will be utilized for creating geological, geophysical, and geomorphological maps.

The interpreted work shall be written in the form of thesis.

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